

SPECIFICATION

TITLE OF THE INVENTION

OZONE PRODUCTION DEVICE

5 BACKGROUND OF THE INVENTION

The present invention relates to an ozone production device which produces ozone in an electrolysis target liquid by electrolysis.

10 In recent years, especially problems of infectious diseases by bacteria such as Legionella generated in a bathroom and the like have attracted attentions. The generation of fungi or the propagation of bacteria such as Legionella is activated in an environment of the bathroom at a high temperature and humidity, and these fungi and
15 Legionella bacteria supposedly enter bodies and cause the infectious diseases. The fungi and Legionella bacteria propagated in the environment of the bathroom or the like at the high temperature and humidity are attached to a bath heater, tiles and the like, and mixed in hot water pooled
20 in the bath heater. When a person inhales steam by the hot water, the bacteria enter the body. In addition to the bathroom, in places equipped with water supplies, such as a kitchen, when small dust of food, water or the like is rotten, the bacteria propagation is caused.

25 Thus, on the bath heater, tiles, and kitchen to which the bacteria such as fungi and Legionella have been attached, a chloric disinfectant is usually sprayed,

whereby the bacteria such as the fungi are perished and further propagation is prevented.

The chloric disinfectants for general use are adjusted by injection of chemicals such as sodium hypochlorite, and many of the disinfectants are adjusted to be alkaline. Therefore, the disinfectants generate a poisonous chlorine gas when mixed with acid chemicals, and a problem arises that accidents occur during the use. There is another problem that it is difficult to remove bacteria, spores, protozoa and the like which are resistant to chlorine by the chloric disinfectant.

To solve the problems, it has been known that sterilization is carried out by the use of ozone as a substance high in sterilization ability. However, ozone is dissolved in water for an excessively short time.

Therefore, unless ozone is used immediately after produced, a sterilization effect by ozone cannot be obtained.

Therefore, in a method of using ozone in the sterilization, ozone produced by a discharge system is dissolved in water,

an ozone-containing ozone water is produced and sprayed to a sterilization object, or the sterilization object is immersed in the ozone water, or the ozone water is injected into water which is a sterilization object. When ozone is used in the sterilization in this manner, it is very

difficult to dissolve ozone produced by the discharge system in water. Therefore, a part of produced ozone is not dissolved in the water, and is discharged as gas ozone.

To solve this problem, as a method of directly producing ozone in water, there has been a method in which at least one pair of electrodes for electrolysis are immersed in an electrolysis target liquid, voltages are applied to these electrodes for the electrolysis to produce a hypochlorous acid and ozone in the electrolysis target liquid, and the water containing hypochlorous acid and ozone is used to perform sterilization (see Japanese Patent Application Laid-Open No. 9-38655, for example).

As described above, in the ozone production method by the conventional discharge system, produced ozone has to be dissolved in water, and gas ozone which has not been dissolved requires a decomposition treatment, and therefore there has been a problem that a device and operation are complicated. In the ozone production method by the electrolysis system, a diaphragm needs to be disposed between anode and cathode sides to separate and coat the respective sides in order to sufficiently produce ozone, and this has caused a problem that the device is complicated and enlarged.

SUMMARY OF THE INVENTION

The present invention has been developed to solve conventional technical problems, and an object thereof is to provide an ozone production device capable of easily producing ozone in an electrolysis target liquid without performing any laborious assembly operation.

In the ozone production device of the present invention, a voltage is applied between an anode and a cathode, and ozone is produced in the electrolysis target liquid by electrolysis, the anode is integrated with the cathode at a predetermined interval without separating the anode from the cathode, and an electrolytic portion is constituted.

According to the present invention, in the ozone production device in which the voltage is applied between the anode and the cathode to produce ozone in the electrolysis target liquid by the electrolysis, the anode is integrated with the cathode at the predetermined interval without separating the anode from the cathode so as to constitute the electrolytic portion. Therefore, the electrolytic portion is injected and immersed in the electrolysis target liquid as a target in which ozone is to be produced. Accordingly, it is possible to easily electrolyze the electrolysis target liquid and to produce ozone.

Moreover, the anode is integrated with the cathode with an interval optimum for the production of ozone. Therefore, when the electrolytic portion is just injected into the electrolysis target liquid, the anode and cathode can be disposed at the interval optimum for the production of ozone, and a laborious operation at a use time can be avoided. Furthermore, since the anode and cathode are disposed without being separated from each other, a

disadvantage that the device is complicated and enlarged can be avoided.

Moreover, in the ozone production device of the present invention, the anode and cathode comprise water-permeability members capable of passing the electrolysis target liquid.

According to the present invention, since the anode and cathode comprise the water-permeability members capable of passing the electrolysis target liquid, surface areas of the anode and cathode can be expanded, and production efficiency of ozone can further be enhanced.

Moreover, in the ozone production device of the present invention, a film having insulation properties and ion permeability is disposed.

According to the present invention, since the film having the insulation properties and ion permeability is disposed between the anode and the cathode, it is possible to reduce the interval between the anode and the cathode. Accordingly, even when the applied voltage is lowered, ozone can be effectively produced in the electrolysis target liquid.

Especially, the electrolytic portion of the present invention holds the film having the insulation properties and ion permeability by the anode and cathode. Therefore, when the electrolytic portion is immersed in the electrolysis target liquid, ozone produced on an anode side has difficulty in passing through the film and directly

moving toward the cathode, because the film constitutes a solid barrier. This can avoid a disadvantage that ozone moves toward the cathode immediately after produced and is reduced in oxygen or hydroxide ion or water and disappears without fulfilling a sterilization effect by ozone. It is possible to lengthen a time for which ozone is dissolved in the electrolysis target liquid, and therefore the sterilization effect by ozone can be efficiently obtained.

Moreover, when a hydrogen ion and hydroxide ion produced by the anode and cathode of the electrolysis target liquid react in the electrolysis target liquid, the electrolysis target liquid can be maintained to be neutral. This can avoid a disadvantage that pH of the electrolysis target liquid fluctuates on the anode and cathode sides, and the device can be simplified, or it is possible to avoid a laborious operation for treating the electrolysis target liquid with a special pH adjustor.

Moreover, in the ozone production device of the present invention, the film is a cation-exchange film.

According to the present invention, since the cation-exchange film is disposed between the cathode and the anode, ozone can be further efficiently produced in the electrolysis target liquid.

Especially, in the electrolytic portion of the present invention, the cation-exchange film is held by the anode and cathode. Therefore, when the electrolytic portion is immersed in the electrolysis target liquid, for

ozone and proton produced on the anode side, only the proton can be passed via the cation-exchange film, and ozone, anion, dissolved gas and the like are not passed. This can avoid the disadvantage that ozone moves toward the cathode immediately after produced and is reduced in oxygen or hydroxide ion or water and disappears without fulfilling the sterilization effect by ozone. It is possible to lengthen the time for which ozone is dissolved in the electrolysis target liquid, and therefore the sterilization effect by ozone can be efficiently obtained. The proton is movable toward the cathode via the cation-exchange film. Therefore, even when the applied voltage is lowered as compared with the use of the film having ion permeability, ozone can be efficiently produced in the electrolysis target liquid.

Furthermore, when the hydrogen ion and hydroxide ion produced in the anode and cathode of the electrolysis target liquid react in the electrolysis target liquid, the electrolysis target liquid can be maintained to be neutral. This can avoid the disadvantage that the pH or the electrolysis target liquid fluctuates on the anode and cathode sides, and the device can be simplified, or it is possible to avoid the laborious operation for treating the electrolysis target liquid by any special pH adjustor after the electrolysis.

Moreover, in the ozone production device of the present invention, the electrolytic portion is fixed in a

storage tank in which the electrolysis target liquid is stored.

According to the present invention, the electrolytic portion is fixed in the storage tank in which the electrolysis target liquid is stored, and therefore
5 ozone can be stably produced in the electrolysis target liquid in the storage tank.

Moreover, in the ozone production device of the present invention, at least a part of the electrolytic
10 portion is immersed in the electrolysis target liquid in the storage tank in which the electrolysis target liquid is stored, so that the electrolytic portion is movable in the electrolysis target liquid.

According to the present invention, at least a
15 part of the electrolytic portion is immersed in the electrolysis target liquid in the storage tank in which the electrolysis target liquid is stored, so that the electrolytic portion is movable in the electrolysis target liquid. An installation place of the electrolytic portion
20 can be optionally changed, and convenience is enhanced.

Moreover, in the ozone production device of the present invention, a material constituting the anode and/or the cathode comprises a metal or metal oxide containing ruthenium and niobium, or a metal or metal oxide containing
25 platinum and tantalum.

According to the present invention, in the above-described inventions, the material constituting the anode

and/or the cathode comprises the metal or metal oxide containing ruthenium and niobium, or the metal or metal oxide containing platinum and tantalum. Therefore, production efficiency of ozone is further enhanced.

5 Moreover, in the ozone production device of the present invention, the electrolytic portion is covered with a cover member having the insulation properties and water permeability.

10 According to the present invention, the electrolytic portion is covered with the cover member having the insulation properties and water permeability, it is therefore possible to avoid a disadvantage that fingers directly touch the anode or the cathode, and handling properties of the electrolytic portion can be enhanced.

15 Moreover, in the ozone production device of the present invention, the electrolytic portion comprises a heavy bob member in a lower part.

20 According to the present invention, since the electrolytic portion comprises the heavy bob member in the lower part, the electrolytic portion can be prevented from floating in the electrolysis target liquid, and ozone can be produced by the electrolysis of the electrolysis target liquid in an appropriate state.

25 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an explanatory view schematically showing an ozone production device of the present

invention;

FIG. 2 is a constitution diagram of an electrolytic portion;

5 FIG. 3 is a partially enlarged explanatory view of the electrolytic portion;

FIG. 4 is a constitution diagram of the electrolytic portion of another embodiment;

FIG. 5 is a diagram showing an ozone production amount with respect to a current value on each condition;

10 FIG. 6 is a diagram showing the ozone production amount with respect to the current value on each condition;

FIG. 7 is a diagram showing a voltage with respect to the current value on each condition; and

15 FIG. 8 is a constitution diagram of a discharge container.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described hereinafter with reference to the drawings. FIG. 20 1 is a schematic explanatory view showing an outline of an ozone production device 1 of an embodiment of the present invention, FIG. 2 is a structural explanatory view of an electrolytic portion 3, FIG. 3 is a partially enlarged view of the electrolytic portion 3, and FIG. 4 is a partially enlarged view of the electrolytic portion 3 of another 25 embodiment. The ozone production device 1 in the present embodiment electrolyzes a tap water which is an

electrolysis target liquid stored in a storage tank 2 such as a bathtub to perform a sterilization treatment of the storage tank 2.

5 The ozone production device 1 is constituted of the electrolytic portion 3 integrally formed with a power supply portion 4 so that the device can be easily projected into the storage tank 2. In the present embodiment, the electrolytic portion 3 is constituted of one pair of electrodes for electrolysis including an anode 5 and a
10 cathode 6, and a cation-exchange film 7 for integrally disposing the anode 5 and cathode 6 while insulating the anode from the cathode. The anode 5 and cathode 6 of the electrolytic portion 3 are connected to the power supply portion 4 via wirings 8, 9, respectively. The power supply
15 portion 4 controls power conduction to the anode 5 and cathode 6.

The anode 5 is formed of a metal or metal oxide including, for example, ruthenium (Ru) and niobium (Nb), or platinum (Pt) and tantalum (Ta), which is a material
20 capable of easily producing ozone by electrolysis. The cathode 6 is formed of a calcined metal of platinum (Pt). These anode 5 and cathode 6 are meshed water-permeability members in order to secure water permeability. In the present embodiment, each of the anode 5 and cathode 6 has,
25 for example, a length of 4 cm to 6 cm, a width of about 2 cm, and a thickness (including a catalyst applied onto the surface) of about 1 mm.

The cation-exchange film 7 is formed in a dimension slightly larger than that of the anode 5 or the cathode 6, and in the present embodiment, for example, Nafion (trade name) film is used. Moreover, the anode 5 is bonded to one surface of the cation-exchange film 7 and the cathode 6 is bonded to the other surface of the film to constitute the electrolytic portion 3. Accordingly, the cation-exchange film 7 is held by the anode 5 and cathode 6, and a distance between these anode 5 and cathode 6 corresponds to only the thickness of the cation-exchange film 7. Accordingly, the distance between the electrodes can be remarkably reduced, and electrolysis efficiency can be enhanced.

It is to be noted that in the present embodiment, since the cation-exchange film 7 is disposed between the anode 5 and the cathode 6, the distance between the electrodes corresponds to only the thickness of the cation-exchange film 7. However, when the film is not disposed between the electrodes, as shown in FIG. 4, an insulating spacer 15 formed, for example, of a silicon rubber is disposed so as to obtain a distance, for example, of about 4 mm between the electrodes. It is to be noted that the spacer 15 secures a constant distance between the anode 5 and the cathode 6, but does not restrict movements of ions and water between the anode 5 and the cathode 6, unlike the cation-exchange film 7.

Moreover, the integrated anode 5, cathode 6, and

cation-exchange film 7 are provided with a cover member 11 formed of an insulating material in order to prevent fingers from touching the anode 5 and cathode 6. It is to be noted that the insulating material does not react to ozone, such as polyethylene fluoride based fiber. In order to secure the water permeability with respect to the electrolytic portion 3, the cover member 11 is formed in a mesh form to such an extent that the fingers are not caught. A weight (heavy bob member) 12 is disposed in a lower part of the cover member 11.

By the above-described constitution, when ozone is produced in the electrolysis target liquid in the storage tank 2 such as the bathtub, the electrolytic portion 3 covered with the cover member 11 is projected into the storage tank 2 to immerse the electrolytic portion 3 in the electrolysis target liquid. Moreover, the power supply portion 4 supplies power to the anode 5 and cathode 6 of the electrolytic portion 3.

Here, since the electrolysis target liquid pooled in the bathtub or the like is usually a tap water, the electrolysis target liquid contains a predetermined amount of or more, for example, about 30 ppm or more chloride ion beforehand. Therefore, when the voltage is applied to the anode 5 and cathode 6, the chloride ion discharges electrons to produce chlorine in the anode 5 as shown in FIG. 3. Therefore, chlorine is dissolved in water to produce hypochlorous acid.

Moreover, the anode 5 is formed of the metal or metal oxide containing ruthenium and niobium, or containing platinum and tantalum as described above, and the chloride ion exists in the tap water which is the electrolysis target liquid. Therefore, potential rises, and the hydroxide ion in the electrolysis target liquid produces active oxygen such as oxygen and ozone. It is to be noted that the anode 5 is formed in the mesh form as described above, and therefore produced ozone is easily discharged from the anode 5.

On the other hand, in the cathode 6, chlorine or oxygen or ozone produced in the anode 5 is reduced to the chloride ion or hydroxide ion. That is, a reaction reverse to a chemical reaction in the anode 5 occurs.

Here, since the cation-exchange film 7 is disposed between the anode 5 and the cathode 6, the cation can be passed through the surface in contact with the cation-exchange film 7 on the anode 5 and cathode 6 sides via the cation-exchange film 7, and transmission of anion and dissolved gas is impossible. Therefore, the anion and dissolved gas are movable in a portion other than the surface in contact with the cation-exchange film 7.

Therefore, chlorine and ozone produced in the anode 5 cannot move toward the cathode 6 in a shortest distance through the cation-exchange film 7. Accordingly, chlorine and ozone on the anode 5 side moves toward the cathode 6 while avoiding the cation-exchange film 7, that

is, turning outside the cation-exchange film 7, and cause a reduction reaction in the cathode 6.

Accordingly, ozone produced on the anode 5 side cannot pass through the cation-exchange film 7, it is therefore possible to avoid the disadvantage that ozone is reduced to oxygen or hydroxide ion or water, and an existence time of ozone can be lengthened. Therefore, a content of ozone in the electrolysis target liquid increases, and a sterilization effect by ozone can be enhanced. Accordingly, in the present embodiment, scale or slime or the like can be removed from the bathtub in which the electrolysis target liquid is pooled without using any special chemical such as detergent.

Here, an ozone production amount on each condition will be described with reference to experiment results of FIG. 5. In an experiment, there were used: a device (①) in which the electrode of the metal or metal oxide containing ruthenium and niobium was used in the anode 5 and the cation-exchange film 7 was disposed between the anode 5 and the cathode 6; a device (②) in which the electrode of the metal or metal oxide containing ruthenium and niobium was similarly used in the anode 5 and the spacer 15 was disposed between the anode 5 and cathode 6 to obtain an interval of about 4 mm; a device (③) in which the calcined platinum electrode was used in the anode 5 and the cation-exchange film 7 was disposed between the anode 5 and cathode 6; and a device (④) in which the calcined

platinum electrode was used in the anode 5 and the spacer 15 was disposed between the anode 5 and cathode 6 to obtain an interval of about 4 mm. The electrolysis target liquids were electrolyzed, and produced amounts of ozone were measured. It is to be noted that the calcined platinum electrode is used in the cathode 6 in any device, and 150 ml of simulated tap water having a chloride ion concentration of 17.75 ppm at a water temperature of 15°C is used in the electrolysis target liquid. The electrolysis was carried out for one minute on these conditions.

In accordance with the experiment, it has been seen that the produced amount of ozone is large in a case where the cation-exchange film 7 is disposed between the anode 5 and cathode 6 as compared with a case where the integrally disposed electrolytic portion 3 with an interval (about 4 mm in the present embodiment) comparatively appropriate for the production of ozone is used. It has also been seen that the produced amount of ozone is large in a case where the electrode of the metal or metal oxide containing ruthenium and niobium is used in the anode 5 as compared with a case where the calcined platinum electrode is used.

From this, it has been seen that the disposing of the cation-exchange film 7 between the anode 5 and cathode 6 is further preferable for the production of ozone as compared with a case where the predetermined interval is

disposed without disposing any film. The use of the electrode of the metal or metal oxide containing ruthenium and niobium is further preferable for the production of ozone as compared with the use of the calcined platinum electrode.

On the other hand, the reduced chloride ion or hydroxide ion cannot pass through the cation-exchange film 7 on the cathode 6 side. Therefore, the ion moves toward the anode 5 while avoiding the cation-exchange film 7, and is oxidized again to chlorine or oxygen or ozone. The cation-exchange film 7 passes only the cation. Therefore, the hydrogen ion which has moved toward the cathode 6 from the anode 5 is reduced to the hydrogen gas in the cathode 6, and is discharged to the outside as a gas.

Here, in the present embodiment, the cation-exchange film 7 is disposed between the anode 5 and cathode 6, but is formed in a dimension slightly larger than that of the anode 5 and cathode 6. Therefore, the electrolysis target liquids on the anode 5 and cathode 6 sides are not divided by the cation-exchange film 7. Accordingly, the hydrogen and hydroxide ions produced on the anode 5 and cathode 6 sides of the electrolysis target liquid react in the electrolysis target liquid, and the electrolysis target liquid can accordingly maintain its neutrality. Therefore, it is possible to avoid fluctuations of pH as the electrolysis proceeds, such as inclination to acidity on the anode 5 side and inclination to alkalinity on the

cathode 6 side, and therefore the device can be simplified. The laborious operation for treating the electrolysis target liquid in the special pH adjustor after the electrolysis can be avoided.

5 As described above in detail, in accordance with the present embodiment, the electrolytic portion 3 is integrally formed in which the anode 5 and cathode 6 are disposed at the predetermined interval, that is, via the thickness of the cation-exchange film 7. Therefore, the
10 electrolytic portion 3 is projected into the storage tank 2, the voltage is applied to the electrolytic portion immersed in the electrolysis target liquid by the power supply portion 4, and accordingly the electrolysis target liquid can be easily electrolyzed to produce ozone.

15 Moreover, the anode 5 and cathode 6 are integrated via the interval which is optimum for the production of ozone. Therefore, when the electrolytic portion 3 is simply projected into the electrolysis target liquid, it is possible to disposed the anode 5 and cathode 6 at the
20 interval with an optimum production efficiency of ozone, and the laborious operation at the use time can be avoided. When the interval between the anode 5 and cathode 6 is remarkably reduced as in the present embodiment, ozone can be produced with a minimum applied voltage, and the ozone
25 production efficiency can be enhanced. In order to further enhance the electrolysis efficiency of the electrolysis target liquid and to increase the produced amount of ozone,

halides such as sodium chloride may also be added to the electrolysis target liquid.

Furthermore, since the anode 5 and cathode 6 have the meshed form with the water permeability, the surface areas can be expanded, and the production efficiency of ozone can further be enhanced.

Moreover, in the ozone production device 1 of the present embodiment, the electrolytic portion 3 can be projected into any storage tank, and is also movable freely in the electrolysis target liquid. Therefore, the installation place of the electrolytic portion 3 can optionally be changed, and convenience is enhanced. It is to be noted that in the present embodiment, an operator moves the electrolytic portion 3 to an target installation place. Additionally, moving means may be disposed in a lower part of the electrolytic portion 3, and the electrolytic portion 3 may also be moved freely by a control device (not shown) during the electrolysis to enhance the ozone production efficiency of the whole electrolysis target liquid.

Furthermore, since the weight 12 is disposed in the lower part of the electrolytic portion 3 in the present embodiment, the electrolytic portion 3 can be prevented from floating up in the electrolysis target liquid, and ozone can be produced in the appropriate state by the electrolysis of the electrolysis target liquid. It is to be noted that even when the electrolytic portion 3 is

disposed in a closing member that freely closes a discharge port formed in a bottom wall of the bathtub, a similar effect can be obtained.

Moreover, since the electrolytic portion 3 is
5 provided with the cover member 11 as described above, the disadvantage that the fingers touch the anode 5 or cathode 6 can be avoided, and handling properties of the electrolytic portion 3 can be enhanced.

It is to be noted that in the present embodiment,
10 the cation-exchange film 7 is disposed between the anode 5 and cathode 6. Additionally, a neutral film (film having no selective permeability) having the insulation properties and ion permeability and having no permeability to the ozone gas may be disposed between the anode 5 and cathode
15 6. In this case, when the anode 5 and cathode 6 are bonded to the neutral film, the anode 5 and cathode 6 can be integrally constituted via the interval corresponding to the thickness of the neutral film.

Moreover, when the neutral film is disposed
20 between the anode 5 and cathode 6, the surfaces in contact with the neutral film on the anode 5 and cathode 6 sides are capable of passing the ions via the neutral film, ozone does not easily pass through the neutral film, and therefore ozone dissolved in the electrolysis target liquid
25 is movable in a portion other than the surface contacting the neutral film.

Therefore, in the same manner as in the above-

described embodiment, the hydrogen and hydroxide ions produced on the anode 5 and cathode 6 sides of the electrolysis target liquid react in the electrolysis target liquid, and accordingly the electrolysis target liquid can maintain its neutrality. This can avoid the disadvantage that the pH of the electrolysis target liquid fluctuates on the anode 5 and cathode 6 sides, respectively, and the device can be simplified. The laborious operation for treating the electrolysis target liquid in the special pH adjustor after the electrolysis can be avoided.

Moreover, since ozone produced on the anode 5 side cannot pass through the neutral film, it is possible to avoid the disadvantage that ozone is reduced to oxygen or the hydroxide ion immediately after produced on the cathode 6 side and disappears without fulfilling any sterilization effect by ozone. Therefore, the time for which ozone is dissolved in the electrolysis target liquid can be lengthened. Accordingly, the sterilization effect by ozone can be efficiently obtained.

Here, the embodiment will be described with reference to the experiment results of FIGS. 6 and 7. FIG. 6 shows the ozone production amount with respect to the current value on each condition, and FIG. 7 shows a voltage with respect to the current value on each condition. In the experiment, by the use of: a device (shown by black triangles in FIG. 6 and by black circles in FIG. 7) using the metal or metal oxide containing ruthenium and niobium

in the anode 5 and using the calcined platinum electrode in the cathode 6 and including the cation-exchange film between the anode 5 and cathode 6; and a device including the neutral film between the anode 5 and cathode 6 (shown
5 by white triangles in FIG. 6 and by white circles in FIG. 7), the electrolysis target liquids were electrolyzed, and the produced amounts of ozone were measured. It is to be noted that 150 ml of simulated tap water having a chloride ion concentration of 17.75 ppm at a water temperature of
10 15°C is used in the electrolysis target liquid in either device. The electrolysis was carried out for one minute on these conditions.

Accordingly, it has been seen that the produced amount of ozone is large in each current value in a case
15 where the cation-exchange film is disposed between the anode 5 and cathode 6 as compared with a case where the neutral film is disposed. It has also been seen that the voltage is low in each current value in a case where the cation-exchange film is disposed between the anode 5 and
20 cathode 6 as compared with a case where the neutral film is disposed.

From this, it has been seen that more ozone can be produced with a low power consumption in the case where the cation-exchange film is disposed between the anode 5 and
25 cathode 6 as compared with the neutral film is disposed. Accordingly, it has been seen that the case where the cation-exchange film is disposed between the anode 5 and

cathode 6 is more preferable for the production of ozone. It is to be noted that it is seen from the experiment result that ozone is produced even in the case where the neutral film is disposed.

5 It is to be noted that in the present embodiment, the electrolytic portion 3 is optionally projected into the storage tank 2 of the electrolysis target liquid, and the electrolysis is performed to produce ozone. Additionally, as shown in FIG. 8, the electrolytic portion 3 may also be
10 fixed and used inside a certain container. For example, the above-described electrolytic portion 3 is fixed in a discharge container 20 including a storage portion 21 in which the electrolysis target liquid is stored, and a
15 discharge portion 22 for discharging the electrolysis target liquid pooled in the storage portion 21 to the outside.

 Moreover, power is supplied to the anode 5 and cathode 6 of the electrolytic portion 3 to produce ozone in the electrolysis target liquid, and the discharge container
20 20 is carried to a place which is to be sterilized/treated by ozone. Furthermore, when the electrolysis target liquid containing ozone produced in the storage portion 21 is discharged from the discharge portion 22, the sterilization by ozone is possible.

25 Accordingly, when the integrally constituted electrolytic portion 3 is fixed inside the storage portion 21, the discharge container 20 capable of discharging ozone

can be easily constituted. Moreover, when the device itself is simplified, the device can further be miniaturized.

As described above in detail, in accordance with the present invention, in the ozone production device in which the voltage is applied between the anode and the cathode to produce ozone in the electrolysis target liquid by the electrolysis, the anode is integrated with the cathode via the predetermined interval to constitute the electrolytic portion without being mutually separated. By the constitution, the electrolytic portion is projected into the electrolysis target liquid constituting the object in which ozone is to be produced, and immersed in the electrolysis target liquid. Accordingly, the electrolysis target liquid can be easily electrolyzed to produce ozone.

Moreover, the anode is integrated with the cathode via the interval optimum for the production of ozone. Therefore, when the electrolytic portion is only projected into the electrolysis target liquid, the anode and cathode can be disposed via the interval optimum for the production of ozone, and the laborious operation at the use time can be avoided. Furthermore, since the anode and cathode are disposed without being separated from each other, it is possible to avoid the disadvantage that the device is complicated and enlarged.

Furthermore, in accordance with the present invention, the anode and cathode are formed of water-

permeability members capable of passing the electrolysis target liquid, therefore the surface areas of the anode and cathode can be expanded, and the production efficiency of ozone can further be enhanced.

5 Additionally, in accordance with the present invention, since the film having the insulation properties and ion permeability is disposed between the anode and the cathode, the interval between the anode and the cathode can be reduced. Accordingly, even when the applied voltage is
10 lowered, ozone can be effectively produced in the electrolysis target liquid.

 Especially in the electrolytic portion of the present invention, the insulating film having the ion permeability is held by the anode and cathode. Therefore,
15 when the electrolytic portion is immersed in the electrolysis target liquid, ozone produced on the anode side has difficulty in passing through the film to directly move toward the cathode, because the film constitutes a solid barrier. This can avoid the disadvantage that ozone
20 moves toward the cathode immediately after produced and is reduced to oxygen or the hydroxide ion or water and disappears without fulfilling any sterilization effect by ozone. Therefore, the time for which ozone is dissolved in the electrolysis target liquid can be lengthened.
25 Accordingly, the sterilization effect by ozone can be efficiently obtained.

 Moreover, the hydrogen and hydroxide ions produced

in the anode and cathode of the electrolysis target liquid react in the electrolysis target liquid, and accordingly the electrolysis target liquid can be maintained to be neutral. This can avoid the disadvantage that the pH of the electrolysis target liquid fluctuates on the anode and cathode sides, respectively, and the device can be simplified. Moreover, the laborious operation for treating the electrolysis target liquid in the special pH adjustor after the electrolysis can be avoided.

Furthermore, in accordance with the present invention, since the cation-exchange film is disposed between the cathode and the anode, ozone can be further efficiently produced in the electrolysis target liquid.

Especially, in the electrolytic portion of the present invention, the cation-exchange film is held by the anode and cathode. Therefore, when the electrolytic portion is immersed in the electrolysis target liquid, for ozone and proton produced on the anode side, only the proton can be passed via the cation-exchange film, and ozone, anion, dissolved gas and the like are not passed. This can avoid the disadvantage that ozone moves toward the cathode immediately after produced and is reduced in oxygen or hydroxide ion or water and disappears without fulfilling the sterilization effect by ozone. It is possible to lengthen the time for which ozone is dissolved in the electrolysis target liquid, and therefore the sterilization effect by ozone can be efficiently obtained. The proton is

movable toward the cathode via the cation-exchange film.
Therefore, even when the applied voltage is lowered as
compared with the use of the insulating film having ion
permeability, ozone can be efficiently produced in the
5 electrolysis target liquid.

Moreover, the hydrogen and hydroxide ions produced
in the anode and cathode of the electrolysis target liquid
react in the electrolysis target liquid, and accordingly
the electrolysis target liquid can be maintained to be
10 neutral. This can avoid the disadvantage that the pH of
the electrolysis target liquid fluctuates on the anode and
cathode sides, respectively, and the device can be
simplified. Furthermore, the laborious operation for
treating the electrolysis target liquid in the special pH
15 adjustor after the electrolysis can be avoided.

Additionally, in accordance with the present
invention, the electrolytic portion is fixed inside the
storage tank in which the electrolysis target liquid is
pooled, and therefore ozone can be stably produced in the
20 electrolysis target liquid in the storage tank.

Moreover, in accordance with the present
invention, at least a part of the electrolytic portion is
immersed in the electrolysis target liquid in the storage
tank in which the electrolysis target liquid is stored, and
25 the electrolytic portion is freely movable in the
electrolysis target liquid. Therefore, the installation
place of the electrolytic portion can be optionally

changed, and the convenience is enhanced.

Furthermore, in accordance with the present invention, the material constituting the anode and/or the cathode comprises the metal or metal oxide containing
5 ruthenium and niobium, or the metal or metal oxide containing platinum and tantalum. Therefore, the production efficiency of ozone is further enhanced.

Additionally, in accordance with the present invention, since the electrolytic portion is covered with
10 the cover member having the insulation properties and water permeability, the disadvantage that the fingers directly touch the anode or cathode can be avoided, and the handling properties of the electrolytic portion can be enhanced.

Moreover, in accordance with the present
15 invention, since the electrolytic portion includes the heavy bob member in the lower part, the electrolytic portion can be prevented from floating up in the electrolysis target liquid, and ozone can be produced in the appropriate state by the electrolysis of the
20 electrolysis target liquid.